Introduction to Measurement & Verification for DOE Super ESPC Projects

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Federal Energy Management Program (FEMP)
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Why Measure and Verify?

Implementing measurement and verification (M&V) strategies in energy performance contracts is required in federal contracts such as the Super Energy Savings Performance Contracts (Super ESPCs). Since energy savings are "guaranteed," the legislation requires the contractor to verify the achievement of energy cost savings each year.

The federal legislation outlining the rules for implementing federal ESPC projects is the Energy Policy Act of 1992 (EPACT). The EPACT legislation includes specific requirements for annual verification of energy cost savings to support the saving guarantee.[1]

There are many reasons to use M&V strategies that go beyond satisfying the law. Properly applied, M&V can:

- accurately assess energy savings for a project,
- allocate risks to the appropriate parties,
- reduce uncertainties to reasonable levels,
- monitor equipment performance,
- find additional savings,
- improve operations and maintenance (O&M),
- verify cost savings guarantee is met, and
- allow for future adjustments as needed.

Overview of M&V

Measuring and verifying savings from performance contracting projects requires special project planning and engineering activities. M&V is an evolving science, although common practices exist. These practices are documented in several guidelines, including the *International Performance Measurement & Verification Protocol* (IPMVP 2001), FEMP *M&V Guidelines: Measurement and Verification for Federal Energy Projects* Version 2.2 (2000), and ASHRAE *Guideline 14: Measurement of Energy and Demand Savings* (2002).

[1]EPACT amended the original authorization for conducting ESPCs, which are in the 1986 amendments to the National Energy Conservation Policy Act of 1978 (NECPA). The annual verification requirements are in EPACT sections 436.35 and 436.37, available through http://www1.eere.energy.gov/femp/financing/superespcs_legislation.html.

Steps to Verify Savings

Regardless of the M&V guideline followed, similar steps are taken to verify the potential for the installed energy conservation measures (ECMs) to achieve savings. These steps include:

Before Project Implementation	Step 1: Define the baseline conditions accurately.
	Step 2: Develop a project-specific Measurement & Verification (M&V) plan.
After Project Implementation	Step 3: Commission the systems to ensure that the proper equipment was installed and is performing to specifications prior to project acceptance.
	Step 4: Post-installation verification ensures that the equipment/systems continue are operating correctly and have the potential to generate the predicted savings.
	Step 5: Regular-Interval Verification During the Performance Period. Verify that the installed equipment has been properly maintained, continues to operate correctly, and continues to have the potential to generate the predicted savings. The data gathered may also be used to determine the actual savings achieved.

These four steps are discussed in detail below.

Step 1: Define the Baseline

Typically, the ESCO defines the baseline as part of the detailed energy survey (DES). Baseline physical conditions (such as equipment inventory and conditions, occupancy, nameplate data, energy consumption rate, control strategies, and so on) are determined during the DES through surveys, inspections, spot measurements, and short term metering activities. Baseline conditions are established for the purpose of estimating savings by comparing the baseline energy use to the post-installation energy use. Baseline information is also used to account for any changes that may occur during the performance period, which may require baseline energy use adjustments. This baseline information is included in the ESCO's *Final Proposal*. It is the agency's responsibility to ensure that the baseline has been properly defined.

After the measure has been installed, one cannot go back and re-evaluate the baseline. It no longer exists! Therefore, it is very important to properly define and document the baseline conditions. Deciding what needs to be monitored (and for how long) depends on factors such as the complexity of the measure and the stability of the baseline, including the variability of equipment loads and operating hours, and the other variables that affect the load.

The primary sources of questions and complaints in Super ESPC projects are the occasional situations where the customer does not feel that savings are being realized. Having adequate documentation of the baseline is critical to resolving any such disagreements.

Step 2: Develop Project Specific Measurement & Verification Plan

The M&V plan is the single most important item in an energy savings "guarantee." Although the M&V plan is usually developed during contract negotiations, it is important that the agency and the ESCO agree upon general M&V approaches to be used prior to starting the Technical Energy Audit. The M&V method(s) chosen has a dramatic affect on how the baseline is defined and what activities are conducted during the audit.

The project specific M&V plan includes project-wide items as well as details for each ECM, including:

- Details of baseline conditions and data collected

- Documentation of all assumptions and sources of data
- What will be verified and when
- Who will conduct the M&V activities
- Schedule for all M&V activities
- Witnessing requirements
- Details of engineering analysis performed
- How energy savings will be calculated
- Utility rates and how they will be used to calculate cost savings
- Detail any operations & maintenance (O&M) cost savings claimed
- Define O&M reporting responsibilities
- Define content and format of all M&V reports (Post-Installation and periodic M&V)
- How & why the baseline (and therefore savings) may be adjusted

The outline for the required M&V Plan is detailed in Attachment 7 of the IDIQ , which is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html .

Step 3: Commissioning

Commissioning of measures and the submittal of a Commissioning Plan and Commission Report are required by the IDIQ (1 November 2006). Commissioning of installed equipment and systems is required. Commissioning assures that the installed systems perform according to the design intent and provide the proper level of services (appropriate lighting levels, comfortable temperatures, etc.). Commissioning is generally completed by the ESCO and witnessed by the agency. In some cases, however, it is contracted out to a third party.

More information on Commissioning for ESPC projects is available in the Draft Commissioning Guidance Document for DOE's Super ESPCs which is available at http://ateam.lbl.gov/mv/docs/Comm_Guide_Doc_Draft_10-19-04.pdf.

The results of the commissioning activities are presented in a *Commissioning Report*, which tells the Agency that the measure or project is ready for acceptance.

Step 4: Post-Installation Verification

Post-installation verification is conducted by both the ESCO and the federal agency to ensure that proper equipment/systems were installed, are operating correctly, and have the potential to generate the predicted savings. Verification methods include surveys, inspections, spot measurements, and short-term metering.

The results of the M&V activities are presented in a *Post-Installation Report* delivered by the ESCO after project acceptance. The outline required for the Post-Installation Report is detailed in Attachment 7 of the IDIQ, which is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html

Step 5: Regular-Interval Verification During the Performance Period

At least annually, the ESCO and the federal agency verify that the installed equipment/systems have been properly maintained, continue to operate correctly, and continue to have the potential to generate the predicted savings. The outline required for the Annual Report is detailed in Attachment 7 of the IDIQ, which is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html

Although an *Annual Report* from the ESCO is required to substantiate savings guarantees, more frequent verification activities can be appropriate. This ensures that the M&V monitoring and reporting systems are working properly, it allows fine-tuning of measures throughout the year based on operational feedback, and it avoids surprises at the end of the year.

M&V Options A, B, C, and D

The M&V protocol mandated for Super ESPC projects is the FEMP *M&V Guidelines: Measurement and Verification for Federal Energy Projects* Version 2.2 (2000). These guidelines group M&V methodologies into four categories: Options A, B, C, and D. The options are generic M&V approaches for energy and water saving projects. Options A, B, C, and D are consistent with those defined in the IPMVP. Having four options provides a range of approaches to determine energy savings depending on the characteristics of the ECMs being implemented and balancing accuracy in energy savings estimates with the cost of conducting M&V.

M&V approaches are divided into two general types: retrofit isolation and whole facility. Retrofit isolation methods look only at the affected equipment or system independent of the rest of the facility; whole-facility methods consider the total energy use while ignoring specific equipment performance. Options A and B are retrofit isolation methods; Option C is a whole-facility method. Option D can be used as either, but is usually applied as a whole facility method. The differences in these approaches are shown in Figure 1.

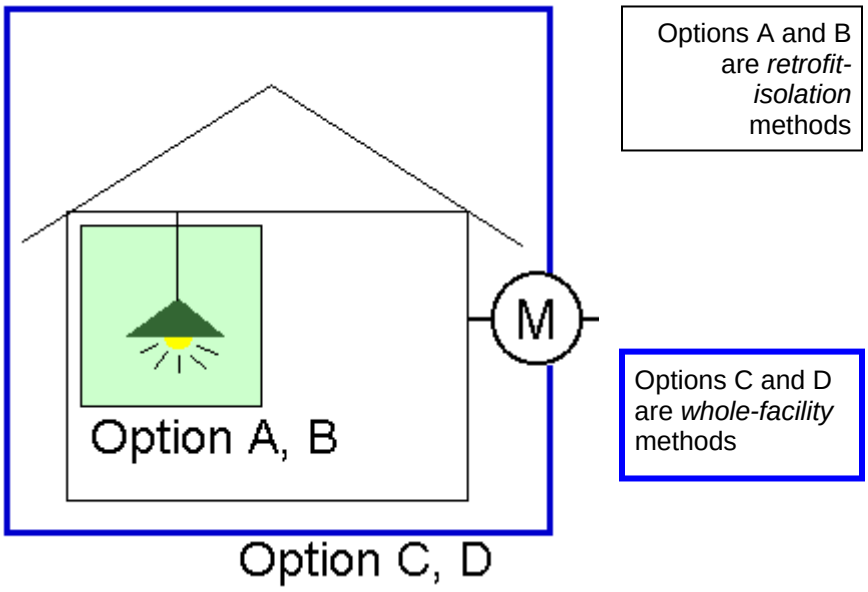


Figure 1: Retrofit isolation (Options A & B) vs. whole-facility M&V methods (Options C & D) — the difference is where the boundary lines are drawn.

There are two fundamental factors that drive energy savings: performance and usage. Performance describes how much or how little energy is used to accomplish a specific task; usage describes how much of the task is required, such as the operating hours that a piece of equipment runs. Lighting provides a simple example: performance would be the Watts required to provide a specific amount of light; usage would be the operating hours per year. A chiller is a more complex system: performance is defined as the energy required to provide a specific amount of cooling (which varies with load); usage is defined by

cooling load profile and the total amount of cooling required. Both performance and usage factors need to be known to determine savings, as shown in Figure 2.

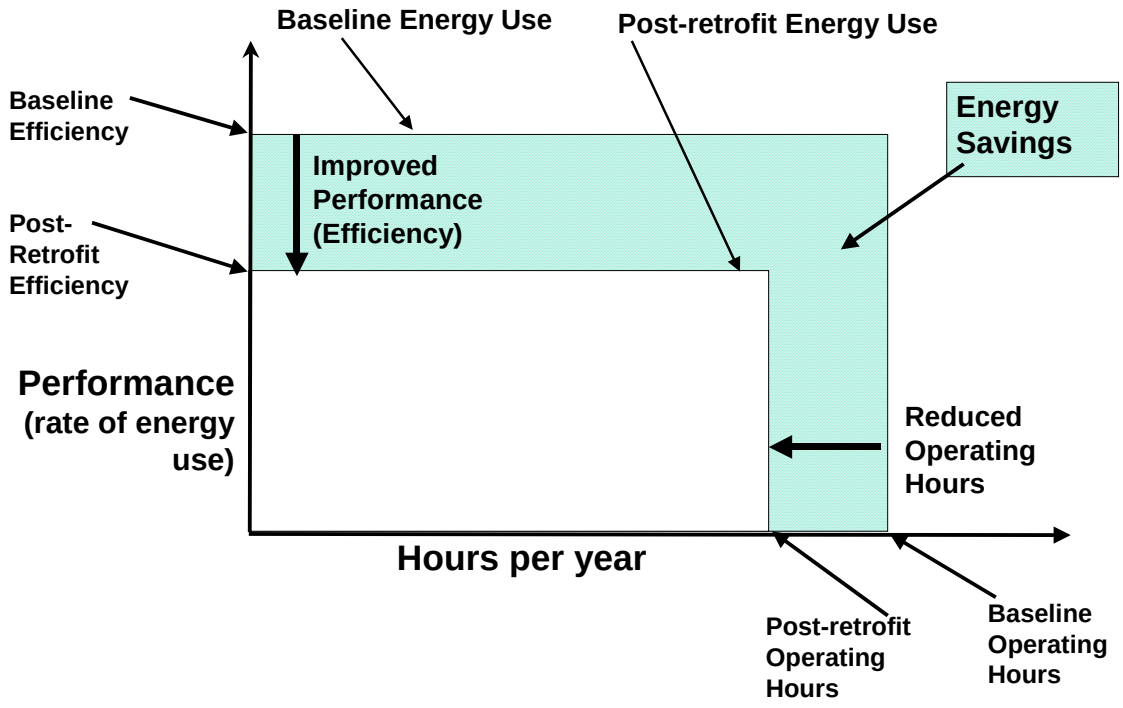


Figure 2: Energy Savings depend on performance and usage.

In Figure 2, the area of the large box represents the total energy used in the baseline case. Reduction in the rate of energy use (increase in performance) or reductions in usage (decrease in operating hours) lead to reduced total energy use, which is represented by the smaller box. The difference between the two boxes – the shaded area – represents the energy savings.

The four generic M&V options are summarized in Table 1 and described in more detail below. Each option has advantages and disadvantages based on site-specific factors and the needs and expectations of the agency. While each option defines an approach to determining savings, savings are not directly measured all savings are estimated values.

Table 1: Overview of M&V Options A, B, C, and D

M&V Option	Performance[1] and Usage[2] Factors	Savings Calculation
Option A – Estimated and Short-Term Measured Factors	Based on a combination of measured and estimated factors. Measurements are spot or short-term taken at the component or system level. Estimated (non-measured) factors are supported by historical or manufacturer's data.	Engineering calculations, component or system models.

M&V Option	Performance[1] and Usage[2] Factors	Savings Calculation
Option B – Periodically or Continuously Measured and Estimated Factors	Based on periodic or continuous measurements taken at the component or system level when variations in factors are expected. Spot or short-term measurements may suffice when variations in factors are not expected.	Engineering calculations, component or system models.
Option C – Utility Billing Data Analysis	Based on long-term whole-building utility meter, facility level, or sub-meter data.	Based on regression analysis of utility billing meter data to account for factors that drive energy use.
Option D – Calibrated Computer Simulation	Computer simulation inputs may be based on a combination of the following: reasonable assumptions based on historical data gathered at facilities, performance specifications of equipment or system being installed, engineering estimates, spot-, short-term, or long-term measurements of system components, and long-term whole-building utility meter data.	Based on computer simulation model calibrated with whole-building or end-use metered data or both.

[1]Performance factors indicate equipment or system performance characteristics, such as kW/ton for a chiller or Watts/fixture for lighting.

[2]Operating factors indicate equipment or system operating characteristics such as annual cooling ton-hours for chillers or operating hours for lighting.

Option A

Option A is a retrofit isolation approach designed for projects in which the potential to generate savings must be verified, and the actual savings can be determined from short-term measurements, engineering calculations, and estimated factors. Post-installation energy use, equipment performance, and usage are NOT measured throughout the term of the contract. Baseline and post-installation energy use is estimated using an engineering analysis of information that does not involve long-term measurements.

The intent of Option A is to verify performance through pre- and post-retrofit measurements. Usage factors can be measured or estimated based upon engineering calculation and experience, operating schedules, operator logs, typical weather data, or other documented information source.

Post-retrofit measurements are made only once. Thereafter, inspections verify that the "potential to perform" exists. As long as the potential to perform is verified, the savings are as originally claimed and do not vary over the contract term. The level of accuracy of the calculated savings depends on the validity of the assumptions and what measurements are made.

Estimated values are commonly referred to as "stipulations', which imparts a legal definition to a non-measured value. Stipulations should thus be used judiciously, such as in cases where it is not cost-effective to measure a value, the ESCO is not responsible for to changes in that value (e.g. weather), or the agency is willing to assume the risk that value is wrong. Option A is *not* "stipulated savings." The selection of which factors to measure should be considered relative to the contractor's responsibilities and the agency's risk tolerance.

Option B

Continuous measurements of both performance and operational factors provide long-term data on the energy use of the equipment or system and show that savings persist.

Option B is a retrofit-isolation or system-level approach. Option B is similar to Option A, but uses periodic or continuous metering during the post-installation period. This method is intended for retrofits with performance factors and operational factors that can be measured at the component or system level and where long-term performance needs to be verified. Short-term periodic measurements can be used when variations in the measured factor are small, and may be sufficient to characterize the baseline. Continuous monitoring information can be used to improve or optimize the operation of the equipment over time, thereby improving the performance of the retrofit. This approach provides the greatest accuracy in the calculation of savings but increases the performance-period cost.

The intent of Option B is to verify performance periodically or continuously with long-term measurements, thus ensuring savings persistence.

Option C

Option C is a whole-building verification method. Savings are based on actual energy consumption as measured by the utility meter(s). Estimated savings will likely vary over the contract term, even when adjusted for weather and other factors.

Option C verification methods determine savings by studying overall energy use in a facility. The evaluation of whole-building or facility-level metered data is completed using techniques ranging from simple billing comparison to multivariate regression analysis. Generally, the overall level of savings must be more than 10% of total metered usage for this method to be effective. Analyses usually consider changes in weather, occupancy, load, and operations and adjust the baseline accordingly. Option C cannot verify the performance of individual measures but will verify the total performance of all measures including their interactions.

Option D

Option D is primarily a whole-building method, but can be used at the component level. Savings are based on the results of a calibrated computer simulation model. Estimated savings may vary over the contract term if real weather data is used.

Option D uses calibrated computer simulation models of component or whole-building energy consumption to determine energy savings. Linking simulation inputs to baseline and post-installation conditions completes the calibration. Characterizing baseline and post-installation conditions may involve metering performance and operating factors before and after the retrofit. Long-term whole-building energy use data as well as periodic system level performance measurements may be used to calibrate the simulation(s). More elaborate models generally improve accuracy of savings calculations, but increase costs. Option D is especially useful where a baseline does not exist (e.g. new construction or major building modification) or the factors responsible for savings are not easily measured (e.g. reduced solar gain and heat loss through new windows).

Using M&V to Manage Risk

One of the primary purposes of M&V is to reduce risk to an acceptable level, which is a subjective judgment based on the agency's priorities and preferences. In performance contracts, risks are allocated between the ESCO and the owner. Management of risk is accomplished through carefully crafted M&V strategies.

"Risk" in the M&V context refers to the uncertainty that expected savings will be realized. Assumption of risk implies acceptance of the potential monetary consequences. Both ESCOs and agencies are reluctant to assume responsibility for factors they cannot control, and stipulating certain parameters in the M&V plan can align responsibilities. For example, usage factors under the agency's control such as lighting operating hours and thermostat setpoints are typically estimated and then stipulated. Using stipulations means that the ESCO and agency agree to use a set value for a parameter throughout the term of the contract, regardless of the actual behavior of that parameter.

If no stipulated values are used and savings are verified based entirely on measurements, then all risk resides with the ESCO, who must show that the guaranteed savings are realized regardless of contributing factors. Alternatively, the agency assumes the risk for the parameters that are stipulated. In the event that the stipulated values overstate the savings, or reductions in use decrease the savings, the agency must still pay the ESCO for the agreed-upon savings. If the actual savings are greater than expected, the agency retains all of the surplus savings.

Risk related to usage stems from uncertainty in operational factors. For example, savings fluctuate depending on weather, how many hours equipment is used, user intervention, and maintenance practices. Since ESCOs often have no control over such factors, they are usually reluctant to assume usage risk. The agency generally assumes responsibility for usage risk by either allowing baseline adjustments based on measurements, or by agreeing to stipulated equipment operating hours and other usage-related factors.

Performance risk is the uncertainty associated with characterizing a specified level of equipment performance. The ESCO is ultimately responsible for selection, application, design, installation, and performance of the equipment and typically assumes responsibility for achieving savings related to equipment performance. To validate performance, the ESCO must demonstrate that the equipment is operating as intended and has the potential to deliver the guaranteed savings.

Using stipulations can be a practical, cost-effective way to reduce M&V costs and allocate risks. Stipulations used appropriately do not jeopardize the savings guarantee, the agency's ability to pay for the project, or the value of the project to the government. However, stipulations shift risk to the agency, and the agency should understand the potential consequences before accepting them. Risk is minimized and optimally allocated through carefully crafted M&V requirements, including diligent estimation of the stipulated values.

Detailed discussion of the appropriate use of stipulations is included in the *Detailed Guidelines for FEMP M&V Option A.* The document details the proper use of Option A in federal performance contracts, and includes specific recommended practices for the most common ECMs. It is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html .

Key M&V Submittals for Super ESPC Projects

The current IDIQ (1 November 2006) and its associated attachments include templates for key submittals. It is available at http://www1.eere.energy.gov/femp/financing/superespcs_espcbasics.html. The key submittals related to M&V in a Super ESCP project are:

- M&V Approach (in *Initial Proposal*)
- Risk & Responsibility Matrix (in *Final Proposal*; See IDIQ Attachment 5)
- Project-specific M&V plan (in *Final Proposal;* See IDIQ Attachment 7)
- Commissioning Approach (in *Final Proposal*)
- Commissioning Plan (separate submittal after approval of *Design & Construction Package*)
- Commissioning Report (separate submittal prior to Project Acceptance)

- Post-installation Report (separate submittal immediately after Project Acceptance, See IDIQ Attachment 7)
- Annual Reports (separate submittal on anniversaries of Project Acceptance, See IDIQ Attachment 7)

In addition to the M&V reporting templates included in IDIQ Attachment 7, both sample and standardized M&V plans are under development. These items are not mandated, but they serve as useful guides for the preparation of M&V plans and reports. They are available electronically from http://ateam.lbl.gov/mv.

M&V Approach

The first M&V-related submittal received on a Super ESPC project will be the M&V Overview section of the *Initial Proposal*. Although very little detail is included in the M&V Overview, it is important that the agency and the ESCO agree on the general M&V approache(s) to be used prior to starting the detailed energy survey (DES). The M&V method(s) chosen have a dramatic affect on how the baseline is defined, determining what activities are conducted during the DES.

Measurement & Verification Plan

The project-specific M&V plan is included in the "Energy Baseline and ECM Performance" section of the *Final Proposal*. The M&V plan is the single most important item in an energy savings "guarantee."

The project-specific M&V plan template included in the IDIQ (Attachment 7) includes project-wide items and details for each ECM, including:

- Details of baseline conditions and data collected
- Documentation of all assumptions and sources of data
- What will be verified and when
- Who will conduct the M&V activities
- Agency witnessing requirements
- Schedule for all M&V activities
- Discussion on risk and savings uncertainty
- Details of engineering analysis performed
- How energy and cost savings will be calculated
- Energy rate structures and escalation rates
- Details of any O&M cost savings claimed
- Definition of O&M reporting responsibilities
- Agreement on how and why the baseline (and therefore savings) may be adjusted

It is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

ESPC Risk & Responsibility Matrix

The project-specific "Risk & Responsibility Matrix" is to be included in the "Management Approach" section of the *Final Proposal.* The blank Matrix is included as part of the current IDIQ (1 November 2006), Attachment 5 available at http://www1.eere.energy.gov/femp/financing/superespcs_espcbasics.html.

"Risk & Responsibility Matrix" details risks and responsibilities that should be considered when developing performance contracts, especially the verification requirements of these performance contracts. This matrix was developed to help identify the important project risks, assess their potential impact, and clarify the party responsible for managing the risk.

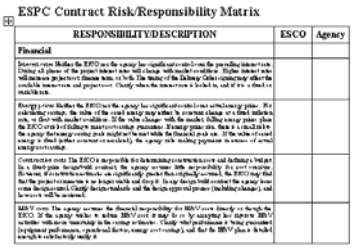
These risks fall into three primary categories: **Financial, Operational,** and **Performance**, as shown in Table 2.

Table 2: Categories Covered in the Risk & Responsibility Matrix

1. Financial	2. Operational	3. Performance
a. Interest Rates	a. Operating Hours	a. Equipment Performance
b. Energy Prices	b. Load	b. Operations
c. Construction Costs	c. Weather	c. Maintenance & Repair
d. M&V Costs	d. User Participation	d. Equipment Replacement
e. Delays		
f. Major Changes to Facility		

The use of the Responsibility Matrix is required by Super ESPC IDIQ contracts. This three-page document describes typical financial and operational responsibilities (e.g., energy costs, operating hours) and their influence on ESPC contracts. One of the blank columns in matrix will be completed by the ESCO to describe the intended allocation of responsibilities in the project and another column for the agency assessment, if appropriate.

For more information on the application of this tool, see an article from the November 2001 *FEMP Focus*, entitled "*Fine-Tuning for Best-Value Super ESPCs Using the Risk/Responsibility Matrix,"* which is available at http://www1.eere.energy.gov/femp/financing/superespcs_espcbasics.html


ESPC Contract Risk/Responsibility Matrix

RESPONSIBILITY/DESCRIPTION	ESCO	Agency
Financial		

Commissioning Report

Commissioning of installed equipment and systems is required. Commissioning ensures that systems are designed, installed, functionally tested in all modes of operation, and capable of being operated and maintained in conformity with the design intent. Commissioning is generally completed by the ESCO and witnessed by the agency.

Commissioning usually requires taking performance measurements to ensure that systems are working properly or to identify problems if they are not. Because of the overlap in commissioning and post-installation M&V activities, some people may confuse the two. The difference is that commissioning ensures that systems are functioning properly; Post-Installation M&V quantifies how well they are working from an energy perspective.

Once commissioning activities have been completed and documented per the Commissioning Plan, a Commissioning Report is submitted, which should indicate to the agency that the measure or project is ready to be accepted.

Post-Installation Report

The results of the installation verification activities are presented in a *Post-Installation Report* delivered by the ESCO following final project acceptance. This report also documents any changes in project scope and energy savings from the *Final Proposal*.

For projects using Option A methods, the post-installation verification is the most important M&V step, because any measurements to substantiate the savings guarantee are made only once. Verification methods may include surveys, inspections, spot measurements, and short-term metering. Thereafter, inspections are to verify that the "potential to perform" exists.

The *Post-Installation Report* includes:

- Project description
- Installation verification – list of installed equipment
- Details of any changes between *Final Proposal* and as-built conditions, including any changes to the estimated energy savings
- Documentation of all post-installation verification activities and performance measurements conducted
- Performance verification — how performance criteria were met
- Validation of construction-period savings (if any)
- Expected savings for the first year

The *Post-Installation Report* template is included as part of the current IDIQ (1 November 2006), Attachment 7, but is available as a separate document at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

Annual Reports

At the end of each year during the performance period, the contractor submits an *Annual Report* to demonstrate that the savings have occurred. For Super ESPC, M&V only needs to show that the overall savings guarantee has been met, not determine actual savings for each ECM.

The *Annual Reports* should include:

- Results/documentation of performance measurements and inspections
- Realized savings for the year (energy, energy costs, O&M costs, other)
- Comparison of actual savings to the guaranteed amounts
- Details of all analysis and savings calculations, including commodity rates used and any baseline adjustments performed
- Summary of operations and maintenance activities conducted
- Details of any performance or O&M issues that require attention

The *Annual Report* template is included as part of the current IDIQ (1 November 2006), Attachment 7, but is available as a separate Word document at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

Other Important M&V Resources

The following items describe key resources on applying M&V in federal performance contracting projects. All are publicly available in electronic format from the Internet, and most reside at http://ateam.lbl.gov/mv and at http://www1.eere.energy.gov/femp/financing/superespcs.html.

M&V Resources & Training Opportunities

The Department of Energy, through Lawrence Berkeley National Laboratory, keeps up to date information on measurement and verification resources. This frequently updated web page provides an extensive collection of resources, describing tools indicative of those available to help users apply M&V protocols.

Resources detailed include current M&V training classes, guidelines from utility, state, and national organizations, case studies, data acquisition equipment such as data loggers, software tools for analysis, and resources on commissioning and retro-commissioning.

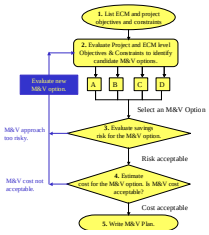
The M&V Resources & Training Opportunities web page is at http://ateam.lbl.gov/mv/docs/MV_Resource_ListR7.htm.

Delivery Order Workshop — M&V Training Section

The Power Point slides used in FEMP's half-day M&V training (part of FEMP's Super ESPC workshops) are a good source of understanding the key issues related to M&V in Super ESPCs. These M&V training slides can be downloaded from http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

M&V Planning Tool

M&V Planning Flowchart



The Federal M&V Team developed the *M&V Planning Tool*, an iterative exercise designed to help develop M&V strategies suited to the unique requirements of individual projects. It is based on a simple flowchart, and provides a flexible framework for introducing key issues related to M&V at an early phase in project development.

The *M&V Planning Tool* can be downloaded from http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

M&V Guidelines: Measurement & Verification for Federal Energy Projects (Version 2.2)

The Federal Energy Management Program (FEMP) published *M&V Guidelines: Measurement and Verification for Federal Energy Management Projects*, Version 2.2, in 2000. These guidelines provide federal energy managers, procurement officials, and energy service providers with standard procedures and guidelines for quantifying savings. Intended for use in ESPCs and other federal projects, the guidelines provide methods for establishing savings called for in the ESPC legislation.

The FEMP protocol is based on and is intended to be compatible with the International Performance Measurement and Verification Protocol (IPMVP), although some differences do exist.

The guidelines are based on four general approaches to assessing savings. The approaches—called Options A, B, C, and D—are designed to cover the spectrum of project types and complexities. For many projects, savings may be verified with a minimum of measurement and at a minimum cost. Other projects

call for a more rigorous M&V approach. In general, the more rigorous the verification requirements, the less uncertainty but the more expensive the verification process will be.

The FEMP *M&V Guidelines* are available through http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

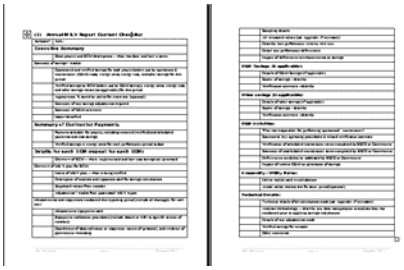
Detailed Guidelines to FEMP M&V Option A

A detailed guide to applying Option A M&V protocols, *Detailed Guidelines for FEMP M&V Option A*, was developed by FEMP as an extension of *M&V Guidelines: Measurement and Verification for Federal Energy Projects* (Version 2.2). This document provides the information that federal agencies, energy service companies (ESCOs), and others need to ensure that if they use the stipulations allowed by Option A methods, they will use them appropriately and achieve the intended effect. *Detailed Guidelines for FEMP M&V Option A* is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

International Performance Measurement & Verification Protocol (IPMVP)

IPMVP was published in 2001 and, like the FEMP *M&V Guidelines*, uses Options A, B, C, and D to assess savings. The IPMVP is available through http://www.evo-world.org/.

FEMP M&V Review Instructions



FEMP has developed review instructions to help agencies and Project Facilitators evaluate ESCO M&V submittals. The review instructions are presented in two documents, and cover the M&V Plan, Post-Installation Report, and Annual Report. the documents, *Reviewing Measurement & Verification Plans for Federal ESPC Projects*, and *Reviewing Performance Reports for Federal ESPC Projects* available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

Agencies are strongly encouraged to use the Post-Installation and Annual Report review instructions during the performance period. The review of an M&V Plan however, requires more engineering expertise, as one must ensure that the Plan is appropriate for a given project.

Including Retro-Commissioning in Federal Performance Contracts

Including retro-commissioning (retro-Cx) in federal performance contracting projects can provide substantial benefits, as discussed in *Including Retro-Commissioning In Federal Energy Saving Performance Contracts*. For effective inclusion in performance contracts, retro-commissioning should be proposed in the initial ESCO proposal.

Detailed explanations of the steps for implementing retro-Cx in a Super ESPC are explained in a companion document *Example Retro-Commissioning Scope of Work*. This scope of work document can be modified and included in the initial ESCO proposal. These documents are available through http://ateam.lbl.gov/mv and http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html.

Planning and Reporting for Operations & Maintenance in Federal ESPCs

Operations and maintenance (O&M) is critical to ensuring that guaranteed savings persist throughout the term of the ESPC. This document provides guidance on allocating O&M, repair and replacement (R&R), and reporting responsibilities in an ESPC contract, which are defined in the M&V plan. This document is available at http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html